Chapter 11
Role of EPA's Pathogen Equivalency Committee in Providing Guidance Under Part 503

11.1 Introduction

One way to meet the pathogen reduction requirements of the Part 503 is to treat sewage sludge in a process "equivalent to" the PFRP or PSRP processes listed in Appendix B of the Part 503 regulation (see Tables 4-2 and 5-1 for a list of these processes):

- Under Class A Alternative 6, sewage sludge that is treated in a process equivalent to PFRP and meets the Class A microbiological requirement (see Section 4.3) is considered to be a Class A biosolids with respect to pathogens (see Section 4.9).

- Under Class B Alternative 3, sewage sludge treated by a process equivalent to PSRP is considered to be a Class B biosolids with respect to pathogens (see Section 5.4).

These alternatives provide continuity with the Part 257 regulation, which required that sewage sludge be treated by a PSRP, PFRP, or equivalent process prior to use or disposal. There is one major difference between Part 257 and Part 503 with respect to equivalency. Under Part 257, a process had to be found equivalent in terms of both pathogen reduction and vector attraction reduction. Under Part 503, equivalency pertains only to pathogen reduction. However, like all Class A and B biosolids, sewage sludges treated by equivalent processes must also meet a separate vector attraction reduction requirement (see Chapter 8).

What Constitutes Equivalency?

To be equivalent, a treatment process must be able to consistently reduce pathogens to levels comparable to the reduction achieved by the listed PSRPs or PFRPs. (These levels, described in Section 11.3, are the same levels required of all Class A and B biosolids.) The process continues to be equivalent as long as it is operated under the same conditions (e.g., time, temperature, pH) that produced the required reductions. Equivalency may be site-specific; equivalency applies only to that particular operation run at that location under the specified conditions, and cannot be assumed for the same process performed at a different location, or for any modification of the process. Processes that are able to consistently produce the required pathogen reductions under the variety of conditions that may be encountered at different locations across the country may qualify for a recommendation of national equivalency (a recommendation that the process will be equivalent wherever it is operated in the United States).

Who Determines Equivalency?

The permitting authority is responsible for determining equivalency under Part 503. The permitting authority and facilities are encouraged to seek guidance from EPA's Pathogen Equivalency Committee (PEC) in making equivalency determinations. The PEC makes both site-specific and national equivalency recommendations.

What Are the Benefits of Equivalency?

A determination of equivalency can be beneficial to a facility, because it reduces the microbiological monitoring burden in exchange for greater monitoring of process parameters. For example a facility meeting Class A requirements by sampling for enteric viruses and viable helminth ova in compliance with Alternative 4 may be able to eliminate this monitoring burden if they are able to demonstrate that their treatment process adequately reduces these pathogens on a consistent basis[1]. Similarly, a facility meeting Class B Alternative 1 requirements by analyzing sewage sludge for fecal coliform may be able to eliminate the need for testing if the process is shown to reduce pathogens to the same extent as all PSRP processes. Equivalency is also beneficial to facilities which may have low cost, low technology systems capable of reducing pathogen populations. Options such as long-term storage, air drying, or low technology composting have been considered by the PEC.

Because equivalency status allows a facility to eliminate or reduce microbiological sampling, it is imperative that the treatment processes deemed equivalent undergo rigorous review to ensure that the Part 503 requirements are met. Obtaining a recommendation of equivalency necessitates a thorough examination of the process and an ex-

[1] A determination of PFRP equivalency will not reduce the monitoring required for *Salmonella* sp. or fecal coliform because all Class A biosolids, even biosolids produced by equivalent processes, must be monitored for *Salmonella* sp. or fecal coliform (see Section 4.3).

tensive sampling and monitoring program. The time needed to review an application is contingent on the completeness of the initial application. Sewage sludge preparers wishing to apply for equivalency should review this chapter carefully and discuss the issue with the regulatory authority in order to determine if equivalency is appropriate for their situation.

Figure 11-1 indicates when application for equivalency may be appropriate.

Recommendation of National Equivalency

The PEC can also recommend that a process be considered equivalent on a national level if the PEC finds that the process consistently produces the required pathogen reductions under the variety of conditions that may be encountered at different locations across the country. A recommendation of national equivalency can be useful for treatment processes that will be marketed, sold, or used at different locations in the United States. Such a recom-

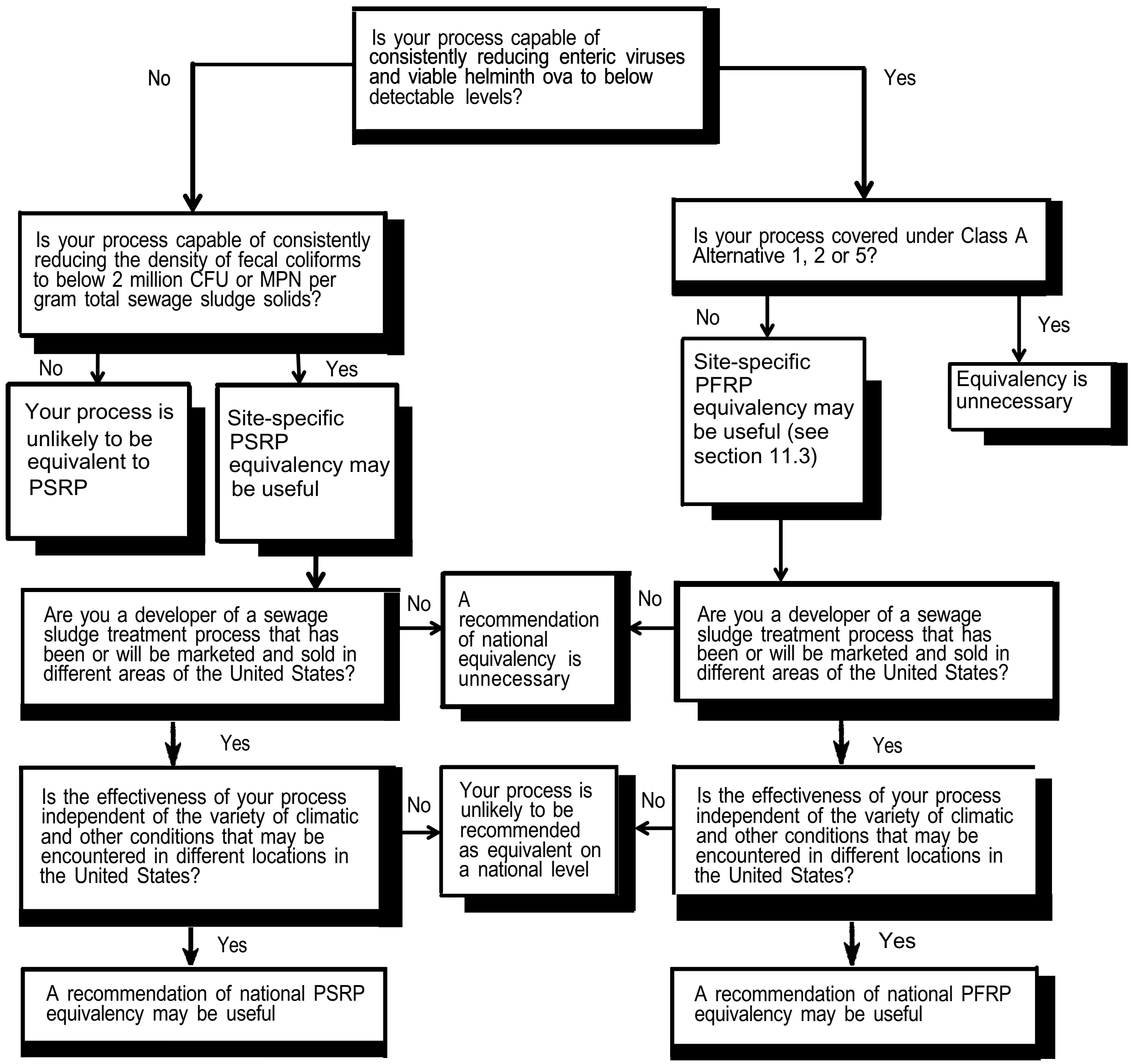

Figure 11-1. When is application for PFRP or PSRP equivalency appropriate?

mendation may be useful in getting PFRP or PSRP equivalency determinations from different permitting authorities across the country.

Role of the Pathogen Equivalency Committee

The U.S. Environmental Protection Agency created the Pathogen Equivalency Committee (PEC) in 1985 to make recommendations to EPA management on applications for PSRP and PFRP equivalency under Part 257 (Whittington and Johnson, 1985). The PEC consists of approximately ten members with expertise in bacteriology, virology, parasitology, environmental engineering, medical and veterinary sciences, statistics, and sewage sludge regulations. It includes representatives from EPA's Research and Development Office, the Office of Water, and the regional offices. The 1993 memorandum included at the end of this chapter describes the role of the PEC.

Guidance and Technical Assistance on Equivalency Determinations

The PEC continues to review and make recommendations to EPA management on applications for equivalency under Part 503. Its members also provide guidance to applicants on the data necessary to determine equivalency, and to permitting authorities and members of the regulated community on issues (e.g., sampling and analysis) related to meeting the Subpart D (pathogen and vector attraction reduction) requirements of Part 503. It is not necessary to consult the PEC with regard to sampling and monitoring programs if a protocol is already approved under one of the Class A alternatives. Figure 11-2 elaborates on the role of the PEC under Part 503.

What's in This Chapter?

This chapter explains how the PEC makes equivalency recommendations and describes how to apply for PEC guidance. The guidance in this chapter may also prove useful for permitting authorities in establishing the information they will need to make equivalency determinations.

11.2 Overview of the PEC's Equivalency Recommendation Process

The first point of contact for any equivalency determination, recommendation, or other guidance is usually the permitting authority. This is the regional EPA office or the State in cases in which responsibility for the Part 503 program has been delegated to the state. Appendix A provides a list of EPA Regional and state Contacts. If PEC involvement is appropriate, the permitting authority will coordinate contact with the PEC.

The PEC considers each equivalency application on a case-by-case basis. Applicants submit information on sewage sludge characteristics, process characteristics, climate, and other factors that may affect pathogen reduction or process efficiency as described in Section 11.5. The committee evaluates this information in light of current knowledge concerning sewage sludge treatment and pathogen reduction, and recommends one of five decisions about the process or process sequence:

- It is equivalent to PFRP.
- It is not equivalent to PFRP.
- It is equivalent to PSRP.
- It is not equivalent to PSRP.
- Additional data or other information are needed.

Site-specific equivalency is relevant for many applications; to receive a recommendation for national equivalency, the applicant must demonstrate that the process will produce the desired reductions in pathogens under the variety of conditions that may be encountered at different locations across the country. Processes affected by local climatic conditions or that use materials that may vary significantly from one part of the country to another are unlikely to be recommended as equivalent on a national basis unless specific material specifications and process procedure requirements can be identified.

If the PEC recommends that a process is equivalent to a PSRP or PFRP, the operating parameters and any other conditions critical to adequate pathogen reduction are specified in the recommendation. The equivalency recommendation applies only when the process is operated under the specified conditions.

If the PEC finds that it cannot recommend equivalency, the committee provides an explanation for this finding. If additional data are needed, the committee describes what those data are and works with the permitting authority and the applicant, if necessary, to ensure that the appropriate data are gathered in an acceptable manner. The committee then reviews the revised application when the additional data are submitted.

11.3 Basis for PEC Equivalency Recommendations

As mentioned in Section 11.1, to be determined equivalent, a treatment process must consistently and reliably reduce pathogens in sewage sludge to the same levels achievable by the listed PSRPs or PFRPs. The applicant must identify the process operating parameters (e.g., time, temperature, pH) that result in these reductions.

PFRP Equivalency

To be equivalent to a PFRP, a treatment process must be able to consistently reduce sewage sludge pathogens to below detectable limits. For purposes of equivalency, the PEC is concerned only with the ability of a process to demonstrate that enteric viruses and viable helminth ova have been reduced to below detectable limits. This is because Part 503 requires ongoing monitoring of all Class A biosolids for fecal coliform or *Salmonella* sp. (see Section

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON. D.C. 20460

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OFFICE OF WATER

MEMORANDUM

SUBJECT: The Role of the Pathogen Equivalency Committee Under the Part 503 ***Standards for the Use or Disposal of Sewage Sludge***

FROM: **Michael B. Cook, Director**
Office of Wastewater Enforcement & Compliance

James A. Hanlon, Acting Director
Office of Science & Technology

TO: Water Division Directors
Regions I - X

PURPOSE

This memorandum explains the role of the **Pathogen Equivalency Committee (PEC)** in providing technical assistance and recommendations regarding pathogen reduction equivalency in implementing the Part 503 ***Standards for the Use or Disposal of Sewage.*** The PEC is an Agency resource available to assist your permit writers and regulated authorities. This information should be sent to your Regional Sludge Coordinators, Municipal Construction Managers, Permits and Enforcement Coordinators, and Solid Waste Offices, State Sludge Management Agencies and others concerned with sewage sludge management.

BACKGROUND

The PEC Under Part 257

The Criteria for Classification of Solid Waste Facilities and Practices (44 FR 53438, September 13, 1979), in 40 CFR Part 257 required that sewage sludge disposed on the land be treated by either a ***Process to Significantly Reduce Pathogens*** **(PSRP)** or a ***Process to Further Reduce Pathogens (PFRP).*** A list of PSRPs and PFRPs were included in Appendix II to Part 257.

In 1985, the PEC was formed to provide technical assistance and recommendations on whether sewage sludge treatment processes not included in Appendix II to Part 257 were equivalent to PSRP or PFRP. Under Part 257, the PEC provided technical assistance to both the permitting authority and to members of the regulated

Figure 11-2. Role of the PEC under Part 503.

A series of options are provided in the Part 503 regulation for meeting the specific requirements for the two classes of pathogen reduction. One of the Class A alternatives is to treat the sewage sludge by a process equivalent to a PFRP and one of the Class B alternatives is to treat the sewage sludge by a process equivalent to a PSRP. The permitting authority must decide whether a process is equivalent to a PFRP or a PSRP, which is the same approach used under Part 257.

THE PEC UNDER 503

Part 503 provides specific criteria and procedures for evaluating bacterial indicators (Fecal coliforms and ***Salmonella*** sp.), enteric virus and viable helminth ova as well as vector attraction reduction. The PEC will continue to support the permitting authority and members of the regulated community under the new Part 503 regulation in evaluating equivalency situations and providing technical assistance in matters such as sampling and analysis. Specifically the PEC:

- will continue to provide technical assistance to the permitting authority and regulated community, including recommendations to the permitting authority about process equivalency. The PEC also will make both site-specific and national (i.e., a process that is equivalent anywhere in the United States where it is installed and operated) recommendations on *process* equivalency .

- will submit recommendations on process equivalency to the Director, Health and Ecological Criteria Division, Office of Science and Technology, who will review those recommendations and then notify the applicant and appropriate permitting authorities of our recommendation.

For site-specific recommendations, requests for **PEC** review or assistance should be made through the appropriate Federal permitting authority (e.g., the State sludge regulatory authority for delegated programs or the EPA Regional Sludge Coordinator for non-delegated programs). For national recommendations, requests for **PEC** review or assistance can also be made through the Director, Health and Ecological Criteria Division (4304T), Office of Science & Technology, **1200 Pennsylvania Avenue, Washington, DC 20460** or directly to the PEC Chairman. The current **PEC** Chairman is: Dr. James *E.* Smith, Jr., U.S. EPA, NRMRL, (National Risk Management Research Laboratory) 26 W Martin Luther King Dr., Cincinnati, OH 45268 (Tele: 513/569-7355).

Additional information and guidance to supplement the pathogen reduction requirements of Part 503 and the procedures to use to reach the **PEC** and the assistance provided by the PEC is provided in "Control of Pathogens and Vector Attraction in Sewage

Figure 11-2. Role of the PEC under Part 503 (continued).

community. The PEC membership has included representatives from the Office of Research & Development (ORD), Office of Wastewater Enforcement & Compliance (OWEC), and the Office of Science & Technology (OST) with extensive experience in microbiology, sludge process engineering, statistics and regulatory issues. The PEC recommendations regarding the equivalency of processes were forwarded to the Office of Science and Technology, which notified applicants about the PEC's recommendations. Final decisions on equivalency were made by the permitting authority.

The Part 503 Sewage Sludge Standards

The 40 CFR Part 503 Standards for the Use or Disposal of Sewage Sludge were published in the **Federal Register** on February 19, 1993 (58 **FR 9248)** under the authority of section **405** of the Clean Water Act, as amended. Part 503 establishes requirements for sewage sludge applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator. Along with the 40 CFR Part 258 Municipal Solid Waste (MSW) Landfill Regulation (56 **FR** 50978, October 9, 1991), which established requirements for materials placed in MSW landfills, the Part 503 requirements for land application of sewage sludge and placement of sewage sludge on a surface disposal site, replaces the requirements for those practices, including the requirement to treat the sewage sludge in either a PSRP or a PFRP, in Part 257.

The Part 503 regulation addresses disease-causing organisms (i.e., pathogens) in sewage sludge by establishing requirements for sewage sludge to be classified either as Class A or Class B with respect to pathogens as an operational standard. Class A requirements are met by treating the sewage sludge to reduce pathogens to below detectable limits, while the Class B requirements rely on a combination of treatment and site restrictions to reduce pathogens. The site restrictions prevent exposure to the pathogens and rely on Natural Environmental processes to reduce the pathogens in the sewage sludge to below detectable levels. In addition to pathogen reduction, a vector attraction reduction requirement has to be met when sewage sludge is applied to the land or placed on a surface disposal site.

Vector attraction reduction requirements are imposed under Part 503 to reduce the potential for spreading of infectious disease agents by vectors (i.e., flies, rodents, and birds). A series of alternative methods for meeting the vector attraction reduction requirement are provided in the rule.

All sewage sludges that are to be sold or given away in a bag or other container for land application, or applied to lawns or home gardens must meet Class A pathogen control and vector attraction reduction requirements. All sewage sludge intended for land application must meet at least the Class B pathogen control and vector attraction reduction requirements. Surface disposal of sewage sludge reguires that Class A or Class B requirements, along with one of the vector attraction reduction practices, be met unless the sewage sludge is covered with soil or other material daily.

Figure 11-2. Role of the PEC under Part 503 (continued).

Sludge" (EPA 625/R-92/013), which will-be updated from time to time by the PEC. This document is an update of the 1989 document "Control of Pathogens in Municipal Wastewatsr Sludge" (EPA/625/10-89/006), and is available from CERI.

If there are any questions about this memorandum, please contact Bob Bastian *from* OWM at 202/564-0635 or *Dr.* Smith from NRMRL at 513-569-7355..

Figure 11-2. Role of the PEC under Part 503 (continued).

4.3) to ensure that *Salmonella* sp. are reduced to below detectable limits (i.e., to less than 3 MPN per 4 grams total solids sewage sludge [dry weight basis]) and that growth of pathogenic bacteria has not occurred. Thus, to demonstrate PFRP equivalency, the treatment process must be able to consistently show that enteric viruses and viable helminth ova are below the detectable limits, shown below:

There are two ways these reductions can be demonstrated:

- Direct monitoring of treated and untreated sewage sludge for enteric viruses and viable helminth ova
- Comparison of the operating conditions of the process with the operating conditions of one of the listed PFRPs.

The process comparison approach to demonstrating equivalency is discussed in Section 11.4.

PSRP Equivalency

To be equivalent to PSRPs, a process must consistently reduce the density of pathogenic viruses and bacteria (number per gram of biosolids (dry weight basis)) in mixed sludge from a conventional plant by equal to or greater than 1 log (base 10). Data indicate that, for conventional biological and chemical treatment processes (e.g. ,digestion and lime treatment) a reduction of 1 log (base 10) in pathogenic virus and bacteria density correlates with a reduction of 1 to 2 logs (base 10) in the density of indicator organisms (Farrell et al., 1985, Farrah et al., 1986). On this basis a 2-log (base 10) reduction in fecal indicator density is accepted as satisfying the requirement to reduce pathogen density by 1 log (base 10) for these types of processes (EPA, 1989c). Specifically, the applicant must demonstrate a 2-log (base 10) reduction (number per gram of biosolids (dry weight basis)) in fecal coliforms.

There is substantial data to indicate that sludge produced by conventional wastewater treatment and anaerobic digestion at 35°C for more than 15 days contains fecal coliforms at average log (base 10) densities (number per gram of biosolids (dry weight basis)) of less than 6.0 (Farrell, 1988). Thus, for processes or combinations of processes that do not depart radically from conventional treatment (gravity thickening, anaerobic or aerobic biological treatment, dewatering, air drying and storage of liquid or sludge cake), or for any process where there is a demonstrated correlation between pathogenic bacteria and virus reduction and indicator organisms reduction, the PEC accepts an average log (base 10) density (no./g. TSS) of fecal coliforms and fecal streptococci of less than 6.0 in the treated sludge as indicating adequate viral and bacterial pathogen reduction. (The average log density is the log of the geometric mean of the samples taken. Calculations of average log density should be based on data from approximately nine sludge samples to account for the natural variability and the variability of the microbiological tests.)

The data submitted must be scientifically sound in order to ensure that the process can reliably produce the required reductions under all the different types of conditions that the process may operate. For example, for processes that may be affected by daily and seasonal variations in the weather, four or more sets of samples taken at different times of the year and during different precipitation conditions (including worst-case conditions) will be needed to make this demonstration.

For national equivalency recommendations, the demonstration must show that the process can reliably produce the desired reductions under the variety of climatic and other conditions that may be encountered at different locations in the United States.

11.4 Guidance on Demonstrating Equivalency for PEC Recommendations

Many of the applicants seeking equivalency do not receive a recommendation from the PEC. The most common reason for this is incomplete applications or insufficient microbiological data. The review process can be both lengthy and expensive, but it can be expedited and simplified if the applicant is aware of the type of data that will be required for the review and submits a complete plan for demonstrating equivalency in a timely fashion.

As described below, equivalency can be demonstrated in one of two ways:

- By comparing operating conditions to existing PFRPs or PSRPs.
- By providing performance and microbiological data.

Comparison to Operating Conditions for Existing PSRPs or PFRPs

If a process is similar to a PSRP or PFRP described in the Part 503 regulation (see Tables 4-2 and 5-1), it may be possible to demonstrate equivalency by providing performance data showing that the process consistently meets or exceeds the conditions specified in the regulation. For example, a process that consistently produces a pH of 12 after 2 hours of contact (the PSRP condition required in Part 503 for lime stabilization) but uses a substance other than lime to raise pH could possibly qualify as a PSRP equivalent. In such cases, microbiological data may not be necessary to demonstrate equivalency.

Process-Specific Performance Data and Microbiologic Data

In all other cases, both performance data and microbiological data (listed below) are needed to demonstrate process equivalency:

- A description of the various parameters (e.g., sewage sludge characteristics, process operating parameters, climatic factors) that influence the microbiological characteristics of the treated sewage sludge (see Section 11.5 for more detail on relevant parameters).

- Sampling and analytical data to demonstrate that the process has reduced microbes to the required levels (see Section 11.3 for a description of levels).
- Discussion of the ability of the treatment process to consistently operate within the parameters necessary to achieve the appropriate reductions.

Sampling and Analytical Methods

Sewage sludge should be sampled using accepted, state-of-the-art techniques for sampling and analyzed using the methods required by Part 503 (see Chapter 9). The sampling program should demonstrate the quality of the sewage sludge that will be produced under a range of conditions. Therefore, sampling events should include a sufficient number of samples to adequately represent product quality, and sampling events should be designed to reflect how the operation might be affected by changes in conditions including climatic and sewage sludge quality variability.

Data Quality

The quality of the data provided is an important factor in EPA's equivalency recommendation. The following steps can help ensure data quality:

- Use of accepted, state-of-the-art sampling techniques (see Chapter 9).
- Obtaining samples that are representative of the expected variation in sewage sludge quality.
- Developing and following quality assurance procedures for sampling.
- Using an independent, experienced laboratory to perform the analysis.

Since processes differ widely in their nature, effects, and processing sequences, the experimental plan to demonstrate that the process meets the requirements for PSRP or PFRP equivalency should be tailored to the process. The permitting authority will evaluate the study design, the accuracy of the data, and the adequacy of the results for supporting the conclusions of the study.

Can Pilot-Scale Data Be Submitted?

Operation of the process at a full-scale facility is desirable. However, if a pilot-scale operation truly simulates full-scale operation, testing on this reduced scale is possible. The permitting authority and the PEC should be contacted to discuss this possibility before testing is initiated. In such cases, it is important to indicate that the data were obtained from a pilot-scale operation, and to discuss why and to what extent this simulates full-scale operation. Any data available from existing full-scale operations would be useful.

The conditions of the pilot-scale operation should be at least as severe as those of a full-scale operation. The arrangement of process steps, degree of mixing, nature of the flow, vessel sizing, proportion of chemicals used, etc. are all part of the requirement. Any substantial degree of departure in the process parameters of the full-scale operation that might reduce the severity of the procedure will invalidate any PEC equivalency recommendations and permitting authority equivalency determinations and will require a retest under the new condition.

11.5 Guidance on Application for Equivalency Recommendations

The following outline and instructions are provided as guidance for preparing applications for equivalency recommendations by EPA's Pathogen Equivalency Committee.

Summary Fact Sheet

The application should include a brief fact sheet that summarizes key information about the process. Any important additional facts should also be included.

Introduction

The full name of the treatment works and the treatment process should be provided. The application should indicate whether it is for recommendation of:

- PSRP or PFRP equivalency.
- Site-specific or national equivalency.

Process Description

The type of sewage sludge used in the process should be described, as well as other materials used in the process. Specifications for these materials should be provided as appropriate. Any terms used should be defined.

The process should be broken down into key steps and graphically displayed in a quantified flow diagram of the wastewater and sewage sludge treatment processes. Details of the wastewater treatment process should be provided and the application should precisely define which steps constitute the beginning and end of sewage sludge treatment.[2] The earliest point at which sewage sludge treatment can be defined as beginning is the point at which the sewage sludge is collected from the wastewater treatment process. Sufficient information should be provided for a mass balance calculation (i.e., actual or relative volumetric flows and solids concentration in and out of all streams, additive rates for bulking agents or other additives). A description of process parameters should be provided for each step of the process, giving typical ranges and mean values where appropriate. The specific process parameters that should be discussed will depend on the type of process and should include any of the following that affect pathogen reduction or process reliability:

Sewage Sludge Characteristics

- Total and volatile solids content of sewage sludge before and after treatment

[2] When defining which steps constitute the "treatment process," bear in mind that all steps included as part of a process equivalent to PSRP or PFRP must be continually operating according to the specifications and conditions that are critical to pathogen reduction.

- Proportion and type of additives (diluents) in sewage sludge
- Chemical characteristics (as they affect pathogen survival/destruction, e.g., pH)
- Type(s) of sewage sludge (unstabilized vs. stabilized, primary vs. secondary, etc.)
- Wastewater treatment process performance data (as they affect sewage sludge type, sewage sludge age, etc.)
- Quantity of treated sewage sludge
- Sewage sludge age
- Sewage sludge detention time

Process Characteristics

- Scale of the system (e.g., reactor size, flow rate)
- Sewage sludge feed process (e.g., batch vs. continuous)
- Organic loading rate (e.g., kg volatile solids/cubic meter/day)
- Operating temperature(s) (including maximum, minimum, and mean temperatures)
- Operating pressure(s) if greater than ambient
- Type of chemical additives and their loading rate
- Mixing
- Aerobic vs. anaerobic
- Duration/frequency of aeration
- Dissolved oxygen level maintained
- Residence/detention time
- Depth of sewage sludge
- Mixing procedures
- Duration and type of storage (e.g., aerated vs. nonaerated)

Climate

- Ambient seasonal temperature range
- Precipitation
- Humidity

The application should include a description of how the process parameters are monitored including information on monitoring equipment. Process uniformity and reliability should also be addressed. Actual monitoring data should be provided whenever appropriate.

Description of Treated Sewage Sludge

The type of treated sewage sludge (biosolids) should be described, as well as the sewage sludge monitoring program for pathogens (if there is one). How and when are samples taken? For what parameters are the samples analyzed? What protocols are used for analysis? What are the results? How long has this program been in operation?

Sampling Technique(s)

The PEC will evaluate the representativeness of the samples and the adequacy of the sampling techniques. For a recommendation of national PFRP equivalency, samples of untreated and treated sewage sludge are usually needed (see Sections 11.3, 4.6, and 10.4). The sampling points should correspond to the beginning and end of the treatment process as defined previously under Process Description above. Chapters 9 and 10 provide guidance on sampling. Samples should be representative of the sewage sludge in terms of location of collection within the sewage sludge pile or batch. The samples taken should include samples from treatment under the least favorable operating conditions that are likely to occur (e.g., wintertime). Information should be provided on:

- Where the samples were collected from within the sewage sludge mass. (If samples were taken from a pile, include a schematic of the pile and indicate where the subsamples were taken.)
- Date and time the samples were collected. Discuss how this timing relates to important process parameters (e.g., turning over, beginning of drying).
- Sampling method used.
- How any composite samples were compiled.
- Total solids of each sample.
- Ambient temperature at time of sampling.
- Temperature of sample at time of sampling.
- Sample handling, preservation, packaging, and transportation procedures.
- The amount of time that elapsed between sampling and analysis.

Analytical Methods

Identify the analytical techniques used and the laboratory(ies) performing the analysis.

Analytical Results

The analytical results should be summarized, preferably in tabular form. A discussion of the results and a summary of major conclusions should be provided. Where appropriate, the results should be graphically displayed. Copies of original data should be provided in an appendix.

Quality Assurance

The application should describe how the quality of the analytical data has been ensured. Subjects appropriate to address are: why the samples are representative; the quality assurance program; the qualifications of the in-house or contract laboratory used; and the rationale for selecting the sampling technique.

Rationale for Why Process Should Be Determined Equivalent

Finally, the application should describe why, in the applicant's opinion, the process qualifies for PSRP or PFRP equivalency. For example, it may be appropriate to describe or review particular aspects of the process that contribute to pathogen reduction, and why the process is expected to operate consistently. Complete references should be provided for any data cited. Applications for a recommendation of national equivalency should discuss why the process effectiveness is expected to be independent of the location of operation.

Appendices

A copy of the complete laboratory report(s) for any sampling and analytical data should be attached as an appendix. Any important supporting literature references should also be included as appendices.

11.6 Pathogen Equivalency Committee Recommendations

Tables 11.1 and 11.2 list processes that the PEC has recommended for use nationally as equivalent to PSRP or PFRP, respectively. Space in the tables limits the detail given for each of the processes. As such individuals having an interest in any of the processes are encouraged to contact either the PEC or the applicant for greater detail on how the process must be operated to be PSRP or PFRP, respectively.

Table 11-1. Processes Recommended as Equivalent to PSRP

Applicant	Process	Process Description
N-Viro Energy Systems, Ltd., Toledo, Ohio	Alkaline Addition to achieve *Lime Stabilization*	Use of cement kiln dust and lime kiln dust (instead of lime) to treat sludge by raising the pH. Sufficient lime or kiln dust is added to sludge to produce a pH of 12 for at least 12 hours of contact
Synox Corp., Jacksonville, FL	OxyOzonation	Batch process where sludge is acidified to pH 3.0 by sulfuric acid; exposed to 1 lb. Ozone/1000 gallons of treated sludge under 60 psig pressure for 60 minutes; depressurized; mixed with 100 mg/l of sodium nitrite and held for $\geq$2 hours; and stored at $\leq$ pH 3.5. Limitations imposed were for total solids to be $\leq$ 4%; temperature must be $\geq$20°C; and total solids must be $\leq$ 6.2% before nitrite addition.

11.7 Current Issues

The PEC is continuing to develop methodologies and protocols for the monitoring of pathogen and vector attraction reduction. Current issues include:

- Establishment of a vector attraction reduction equivalency process
- Conducting round robin laboratory testing for pathogens in sewage sludge and biosolids

In addition, the PEC continues to recommend interpretations of the Part 503 with regard to the sampling and monitoring requirements set forth in this document.

Table 11-2. Processes Recommended as Equivalent to PFRP

Applicant	Process	Process Description
CBI Walker, Inc., Aurora, Illinois	ATP^{TM} Two Stage Sludge Stabilization Process	Sludge is introduced intermittently into a vessel, amounting to 5 to 20% of its volume, where it is heated by both external heat exchange and by the bio-oxidation which results from vigorously mixing air with the sludge (pasteurized) and has a nominal residence time of 18 to 24 hours. Time between feedings of unprocessed sludge can range from 1.2 (@ ~ 65°C) to 4.5 (@ > 60°C) hours. Exiting sludge is heat exchanged with incoming unprocessed sludge. Thus the sludge is cooled before it enters a mesophilic digester. Time and temperature in the first vessel are critical and controlled by the equation below for sludges of ≤ 7% solids, times ≥ 30 minutes, and temperatures ≥50°C. Operations of the reaction vessel during the time-temperature period must be either plug flow or batch mode. $D = 50{,}070{,}000 / 10^{0.1400t}$ where D = time required in days; t = temperature in °C
Fuchs Gas und Wassertechnik, Gmbh, Mayen, Germany	Autothermal Thermophilic Aerobic Digestion	ATAD is a two-stage, autothermal aerobic digestion process. The stages are of equal volume. Treated sludge amounting to 1/3 the volume of a stage is removed every 24 hours from the second stage as product. An equal amount then is taken from the first stage and fed to the second stage. Similarly, an equal amount of untreated sludge is then fed to the first stage. In the 24-hour period between feedings, the sludge in both stages is vigorously agitated and contacted with air. Bio-oxidation takes place and the heat produced increases the temperature. Sludge temperature in the reactors averages between 56 and 57°C for ≥ a 16-hour period, while the overall hydraulic residence time is 6 days.
International Process Systems, Inc., Glastonbury, Connecticut	Type of Composting Process	40 CFR 503.32(a)(7) states that when the within-vessel composting method is employed, the sludge is to be maintained at operating conditions of 55°C or greater for three days, for the product to be PFRP. IPS Process' operation is to further be controlled so that the composting mass passes through a zone in the reactor in which the temperature of the compost is at least 55°C throughout the entire zone, and the time of contact in this zone is at least three days.
K-F Environmental Technologies, Inc., Pompton Plains, NJ	Sludge Drying	Sludge is heated to a minimum temperature of 100°C and indirectly dried to below 10% moisture using oil as a heat transfer medium. The final discharge product has exceeded a temperature of 80°C and is granular dry pellet that can be land applied, incinerated or landfilled. In addition the following conditions must be met: *Dewatered sludge cake is dried by direct or indirect contact with hot gases, and moisture content is reduced to 10% or lower. Sludge particles reach temperatures well in excess of 80°C or the* wet *bulb* temperature *of the gas stream in contact with* the *sludge at the point where it leaves the dryer is in excess of 80°C.*
Lyonnaise des Eaux, Le Pecz-Sur-Seine, France	Two-Phase Thermo-Meso Feed Sequencing Anaerobic Digestion*	Sewage sludge is treated in the absence of air in an acidogenic thermophilic reactor and a mesophilic methanogenic reactor connected in series. The mean cell residence time shall be at least 2.1 days (± 0.05 d) in the acidogenic thermophilic reactor followed by 10.5 days (± 0.3 d) in the mesophilic methanogenic reactor. Feeding of each digester shall be intermittent and occurring 4 times per day every 6 hours. The mesophilic methanogenic reactor shall be fed in priority from the acidogenic thermophilic reactor. Between two consecutive feedings temperature inside the acidogenic thermophilic reactor should be between 49°C and 55°C with 55°C maintained during at least 3 hours. Temperature inside the mesophilic methanogenic reactor shall be constant and at least 37°C.
ATW, Inc. Santa Barbara, CA	Alkaline Stabilization	Manchak process uses quicklime to simultaneously stabilize and pasteurize biosolids. Quicklime, or a combination of quicklime and flyash, is mixed with dewatered biosolids at a predetermined rate in a confined space. An instant exothermic reaction is created in the product wherein the pH is raised in excess of 12 after two hours of contact, in addition, the temperature is raised in excess of 70°C for > 30 minutes.

(continued)

Table 11-2. Continued.

Applicant	Process	Process Description
N-Viro Energy Systems, Ltd., Toledo, OH	Advanced Alkaline stabilization with subsequent accelerated drying	**Alternative 1:** Fine alkaline materials (cement kiln dust, lime kiln dust, quicklime fines, pulverized lime, or hydrated lime) are uniformly mixed by mechanical or aeration mixing into liquid or dewatered sludge to raise the pH to >12 for 7 days. If the resulting sludge is liquid, it is dewatered. The stabilized sludge cake is then air dried (while pH remains >12 for ≥ 7 days) for >30 days and until the cake is ≥ 65% solids. A solids concentration of ≥ 60% is achieved before the pH drops below 12. The mean temperature of the air surrounding the pile is > 5°C (41°F) for the first 7 days. **Alternative 2:** Fine alkaline materials (cement kiln dust, lime kiln dust, quicklime fines, pulverized lime, or hydrated lime) are uniformly mixed by mechanical or aeration mixing into liquid or dewater sludge to raise the pH to > 12 for ≥ 72 hours. If the resulting sludge is liquid, it is dewatered. The sludge cake is then heated, while the pH > 12, using exothermic reactions or other thermal processes to achieve temperatures of ≥ 52°C (126°F) throughout the sludge for ≥ 12 hours. The stabilized sludge is then air dried (while pH > 12 for ≥ 3 days) to ≥ 50% solids.
Synox Corp., Jacksonville, FL	OxyOzonation	Operation occurs in a batch mode and under the following conditions: sludge temperature of > 20°C; sludge solids of < 6% TSS; pH during ozonation of 2.5 - 3.1 and during nitrite contact of 2.6 - 3.5; sludge ORP after ozonation of > 100 mV; nitrite dose of ≥ 670 mg (NO_2)/1 sludge or 16 g (NO_2)/kg sludge solids, whichever is greater is to be mixed into the ozonated sludge. Ozonation takes place in a pressure vessel operating at 60 psig.
Ultraclear, Marlboro, NJ	Microbiological Conditioning and Drying Process (MVCD)	In this process, sludge cake passes through several aerobic-biological type stages (Composting is an example) where different temperatures are maintained for varying times. Stage 1 occurs at 35°C for 7-9 hours; stage 2 occurs at 35-45°C for 8-10 hours; stage 3 occurs at 45-65°C for 7-10 hours; and the last stage is pasteurization at 70-80°C for 7-10 hours. In addition one of two conditions described below must be met: **Condition 1:** *Dewatered sludge cake is dried by direct or indirect contact with hot gases, and moisture content is reduced to 10% or lower. Sludge particles reach temperatures well in excess of 80°C or the wet bulb temperature of the gas stream in contact with the sludge at the point where it leaves the dryer is in excess of 80°C. OR* **Condition** *2:* A) *Using the within-vessel, static aerated pile, or windrow composting methods, the sludge is maintained at minimum operating conditions of 40°C for 5 days. For 4 hours during the period the temperature exceeds 55°C; {Note: another PSRP-type process should be substituted for that* of *composting};* and B) *Sludge is maintained for at least 30 minutes at a minimum temperature of 70°C.*

*Currently a site specific recommendation. Undergoing further study for national equivalency.

References and Additional Resources

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